CLAIMS

What is claimed is:

1. A method for producing a colloidal dispersion of nanoparticles of at least one conductive material in a dense fluid medium, the method comprising the steps of:

(a) providing a reaction vessel for containing the dense fluid medium;

(b) charging the dense fluid medium into the reaction vessel;

(c) providing a rotatable first electrode comprising a first conductive material, the first electrode immersed within the dense fluid medium;

(d) providing a static second electrode comprising a second conductive material, the second electrode immersed within the dense fluid medium and being near to the first electrode;

(e) rotating the first electrode such that the dense medium is circulated between the first and second electrodes; and

(f) imposing an electric potential between the rotating first electrode and the second electrode to create a discharge zone, the electric potential being sufficiently high to dislocate nanoparticles of at least one of the first conductive material or the second conductive material from the respective electrode.

2. The method of claim 1 including the step of passing a gas through the discharge zone.

3. The method claim 2 wherein the gas is a reactive or inert gas.

4. The method of Claim 1 wherein the second electrode is hollow and includes at least one conduit for passage of the dense fluid medium.

5. The method of Claim 1 wherein at least one of the first conductive material or the second conductive material comprises an electrical conductor selected from the group consisting of metals, carbon or combinations thereof.

6. The method of Claim 1 wherein at least one of the first conductive material or the second conductive material comprises an electrical conductor selected from the group consisting of aluminum, antimony, bismuth, carbon, copper, gold, iron, lead, molybdenum, nickel, platinum, silver, tin, tungsten, zinc, rare earths or combinations thereof.

7. The method of Claim 1 wherein at least one of the first conductive material or the second conductive material comprises silver.

8. The method of Claim 1 wherein the nanoparticles have an average diameter of less than about 100 nm as determined by scanning electron microscopy.

9. The method of Claim 1 wherein the nanoparticles have an average diameter of less than about 50 nm as determined by scanning electron microscopy.

10. The method of Claim 1 wherein the nanoparticles have an average diameter of less than about 20 nm as determined by scanning electron microscopy.

11. The method of Claim 1 wherein the nanoparticles have an average diameter of less than about 10 nm as determined by scanning electron microscopy.

12. The method of Claim 1 wherein the first electrode rotates at a speed of up to about 5000 RPM.

13. The method of Claim 12 wherein the first electrode rotates at a speed of at least about 1000 RPM.

14. The method of Claim 1 wherein the first electrode and the second electrode each comprise at least one planar surface, wherein the planar surface of the first electrode is substantially parallel to the planar surface of the second electrode.

15. The method of Claim 14 wherein the substantially planar parallel surfaces are separated by a gap of about 1 mm.

16. The method of Claim 14 wherein the rotating electrode comprises at least one pin made of the first conducting material, the pin projecting from the planar surface of the first electrode towards the planar surface of the second electrode.

17. The method of Claim 14 wherein the planar surface of the first electrode and the planar surface of the second electrode are each disk shaped.

18. The method of Claim 14 wherein the first electrode comprises multiple pins made of the first conducting material, the pins projecting from the planar surface of the first electrode towards the planar surface of the second electrode.

19. The method of Claim 18 wherein the pins are arrayed in a spiral pattern.

20. The method of Claim 18 wherein the distance between the pins and the second electrode is about 0.5 mm.

21. The method of Claim 1 wherein the electric potential is about 200 DCV.

22. The method of Claim 1 wherein the conductive material of both the first electrode and the second electrode comprises silver, the nanoparticles have an average diameter of less than about 20 nm as determined by scanning electron microscopy, the first electrode and the second electrode each comprise at least one planar surface, wherein the planar surface of the first electrode is substantially parallel to the planar surface of the second electrode, the first electrode comprises multiple pins made of the first conducting material, the pins projecting from the planar surface of the first electrode towards the planar surface of the second electrode, wherein the pins are arrayed in a spiral pattern.

23. The method of Claim 1 wherein the dense medium comprises water with bacteria therein and the method is carried out for a time sufficient to kill the bacteria.

24. The colloidal dispersion of nanoparticles of at least one conductive material other than silver in a fluid medium produced by the method of Claim 1.

25. A colloidal dispersion of nanoparticles of at least one conductive material in a fluid medium, wherein the conductive material comprises an electrical conductor selected from the group consisting of

aluminum, antimony, bismuth, carbon, copper, gold, iron, lead, molybdenum, nickel, platinum, silver, tin, tungsten, zinc or combinations thereof.

26. The colloidal dispersion of Claim 25 wherein the nanoparticles have a diameter of less than about 100 nm.

27. The colloidal dispersion of Claim 25 wherein the nanoparticles have a diameter of less than about 20 nm.

28. The colloidal dispersion of Claim 25 wherein the nanoparticles have a diameter of less than about 10 nm.

29. A colloidal dispersion of nanoparticles of silver wherein (i) the nanoparticles have an average particle size less than about 10 nm; (ii) the colloidal dispersion has a silver concentration of less than 3 ppm; and (iii) a 200:1 dilution of the colloidal dispersion is at least 98% effective in killing *salmonella typhimurium* and *Etrobacter agglomerans*.

30. A dense phase plasma discharge apparatus comprising:

(a) a chamber forming a reaction vessel for a dense medium;

(b) a first electrode mounted for rotation about an axis in the chamber having an end piece of conductive material with a planar surface and a plurality of pins in an array projecting from the planar surface;

(c) a second electrode mounted in the chamber and having an end piece of conductive material with a planar surface;

the planar surfaces of the end pieces of the first and second electrodes separated from each other by a gap.

31. The apparatus of Claim 30 wherein the end pieces of the first and second electrodes including the pins on the one end piece are formed of silver.

32. The apparatus of Claim 30 including a motor coupled to the first electrode to selectively drive the first electrode in rotation.

33. The apparatus of Claim 31 wherein the motor is coupled to the first electrode by a magnetic coupling system.

34. The apparatus of Claim 30 wherein the pins are formed in the end piece of the first electrode in a spiral array.

35. The apparatus of Claim 34 wherein the electrode end piece having the pins therein has a cylindrically-shaped, disc cross-section end piece terminated in a ceramic holder in which the pins are mounted.

36. The apparatus of Claim 30 wherein the pins in the pin array are formed of silver.

37. The apparatus of Claim 30 wherein the first electrode mounted for rotation is an upper electrode, and wherein the second electrode is a lower electrode and has channels therein for recirculation of the reaction media in the reaction vessel.

38. The apparatus of Claim 30 wherein the distance between the pins and the planar surface of the end piece of the second electrode is about 0.5 mm or less.

39. A method of producing colloidal silver comprising:

(a) providing a dense medium plasma discharge apparatus comprising:

(1) a chamber forming a reaction vessel for a dense medium;

(2) a first electrode mounted for rotation about an axis in the chamber having an end piece of conductive material with a planar surface and a plurality of pins in an array projecting from the planar surface;

(3) a second electrode mounted in the chamber and having an end piece of conductive material with a planar surface;

the planar surfaces of the end pieces of the first and second electrodes separated from each other by a gap, and wherein the end pieces of the first and second electrodes are formed of silver;

(b) immersing the first and second electrodes in a dense medium;

(c) rotating the first electrode with respect to the second electrode; and

(d) imposing an electrical potential between the first electrode and the second electrode to create a discharge zone, the electrical potential being sufficiently high to dislocate nanoparticles of silver from the first and second electrodes.

40. The method of Claim 39 including the step of passing a gas through the discharge zone.

41. The method of Claim 39 wherein the gas is a reactive or inert gas.

42. The method of Claim 39 wherein the dense medium comprises water with bacteria therein and the method is carried out for a time sufficient to kill the bacteria.

43. The method of Claim 39 wherein the dense medium comprises water and further including the step of adding the dense medium produced by the method of Claim 39 to water contaminated with bacteria to kill the bacteria.